REMARKS

Claims 1-4 are now pending in the application. The purpose of this Preliminary Amendment is to place the English translation of the application in a more traditional U.S. format, and to amend the claims. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Respectfully submitted,

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By: _____
Philip E. Rettig, Reg. No. 34,000
Jason A. Heist, Reg. No. 51,797

HARNESS, DICKEY & PIERCE, P.L.C.
P.O. Box 828
Bloomfield Hills, Michigan 48303
(248) 641-1600

PER/JAH

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Measuring Device with a Hall Sensor and Method for Fabricating the~~Said~~ Measuring Device

~~Description~~

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a National Stage of International Application No. PCT/EP03/04161, filed April 22, 2003. This application claims the benefit of German Patent Application 102 19 473.4, filed April 30, 2002. The disclosure of the above application is incorporated herein by reference.

~~Technical F~~IELD~~ield~~ OF THE INVENTION

The present invention relates to a measuring device with a Hall sensor, particularly for displacement measurements, and to a method for fabricating the~~said~~ measuring device.

BACKGROUND OF THE INVENTION~~Prior Art~~

It is known to use Hall sensors for measuring various parameters. Such sensors are used, for example, for measuring magnetic fields, wattage in high-voltage power lines, for contactless control and regulation of motion, and many other uses~~s~~. The measurement of motion, however, is possible only for very short motion paths of only a few millimeters.

SUMMARY OF THE INVENTION~~Presentation of the Invention~~

The object of the invention is to provide a measuring device with a Hall sensor to be used, in particular, for a displacement measurement ~~and~~ whereby longer paths than before can ~~also~~ be measured with accuracy.

Another object is to provide a method for fabricating the~~said~~ measuring device.

According to the invention, in a measuring device with a Hall sensor, particularly ~~for~~for a displacement measurement, this objective is reached by disposing the Hall sensor in a

magnetic tube centrally ~~and~~ so that it can be moved axially. ~~,~~ ~~e~~Each half of the~~said~~ magnetic tube is~~being~~ cross-magnetized with opposite polarity. Tests have shown that such a measuring device provides very accurate measurements over a considerably longer path length than previous measuring devices with Hall sensors. For example, with a magnetic tube length of 20 mm, an approximately linear range useful for the measurement ~~and~~ having a length of about 14 mm was achieved.

In designing the measuring device, it is important that the Hall sensor be kept in an axially displaceable support, or that it ~~can~~ be displaced axially in a support in a manner such that rotary motions of the Hall sensor relative to the magnetic tube are not possible.

The novel Hall sensor is of simple configuration and is suitable for measurements over long paths. It is not subject to disturbances and is virtually linear. Moreover, it does not require external electronic evaluation circuits. The Hall sensor is moved centrally in the magnetic tube, wherein each half of the~~said~~ tube is~~being~~ cross-magnetized with opposite polarity. The flux density is highest at a distance of a few millimeters from the poles. In the center of the magnetic tube, the~~said~~ flux density is nil and changes its direction.

Compensation of the temperature dependence can be achieved in a simple manner by suitably pairing the Hall sensor with the material of which the magnet is made so that the temperature variations of the two materials ~~will~~ compensate each other.

The fabrication of Hall sensors is in itself known. Different methods can be used to produce the novel magnetic tube for the measuring device. An advantageous method consists of cross-magnetizing a tube made of a magnetizable material in a diametrically opposite manner so that, in the upper part of the tube, one half of the tube is magnetized as the magnetic north pole and the other half of the tube is magnetized as the magnetic south pole. In the bottom part of the tube, the procedure is reversed. That is~~, namely~~ one half of the tube is magnetized as the magnetic south pole and the other half is magnetized as the magnetic north pole.

A very simple method for fabricating the magnetic tube for the measuring device consists of through-magnetizing a tube of magnetizable material perpendicularly to its axis so that one half of the tube is magnetized as the magnetic north pole and the other half of the tube as the magnetic south pole. The tube is then severed across its axis, and one of the parts of the tube is turned 180° relative to the other part of the tube. In this manner are obtained the diametrically opposite north and south poles of the magnetic tube for the measuring device.

BRIEF DESCRIPTION OF THE DRAWINGS

~~Brief Description of the Drawings~~

The invention will now be explained in greater detail with the aid of the practical examples represented in the drawings, in which

Fig. 1 and Fig 2 show a top view and a longitudinal sectional view of the configuration principle of the measuring device;

Fig. 3 shows a diagram of a measuring signal recorded in gauss against the measuring path;

Fig. 4 shows the procedure for diametrically opposite through-magnetization; and

Fig. 5 shows the use of the measuring device in a pneumatic adjustment unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS~~Execution of the Invention~~

Fig. 1 shows a~~the~~ configuration ~~principle~~ of a measuring device 1 according to the present invention. The~~, said~~ measuring device 1 consists~~ing~~ of a magnetic tube 2 with a north pole side 3 and a south pole side 4, as well as a~~the~~ Hall sensor 5 disposed centrally in the magnetic tube 2.

As can be seen from Fig. 2, the magnetic tube 2 is configured so that, as seen in the longitudinal direction, it is divided into two halves. ~~, namely o~~One half 6 is configured with the north pole on the left side and the south pole 4 on the right side, and~~the other part,~~ the other half 7 of magnetic tube 2 is configured~~, being disposed~~ in the reverse manner. That is, ~~namely~~ the north pole 3 is located on the right side and south pole 4 on the left side of the magnetic tube 2. As indicated by double arrow 8, in the magnetic tube 2, the Hall sensor 5 can be moved back and forth in the axial direction. For this purpose, there is provided a support, not shown in detail, which permits axial move-ment of the Hall sensor 5, but prevents the~~said~~ Hall sensor 5 from rotating relative to the magnetic tube 2.

Fig. 3 shows the diagram of a performed test in gauss against the path length. For a measuring device with a magnetic tube of 20-mm length, a usable, nearly linear range of about 14 mm was obtained. Measuring line 10 was obtained by use of a Hall sensor 5 disposed in the middle of the magnetic tube 2, whereas measuring line 20 was obtained with a Hall sensor 5 disposed in the vicinity of the inner wall of the magnetic tube 2. The outer diameter of the magnetic tube was 14 mm and the inner diameter of the magnetic

tube was 8 mm. For both measuring lines 10 and 20, a range 15 is approximately linear and may be viewed as useful.

Fig. 4 shows a side view of the magnetic tube 2 used for the measurements. The height of the tube was H = 24 mm, the inner diameter DE = 8 mm, and the outer diameter DA = 14 mm. The upper half 6 of tube 2 shown in the drawing was through-magnetized from left to right as indicated by arrow 11, whereas the lower half 7 of magnetic tube 2 was through-magnetized in the opposite direction as indicated by arrow 12. This diametrically opposite through-magnetization of magnetic tube 2 afforded the arrangement of magnetic poles 3 and 4 shown in Fig. 2.

Fig. 5 shows a practical example of the application of the novel measuring device 1. Measuring device 1 is disposed centrally in a vacuum adjustment unit used in the motor vehicle field. The configuration of magnetic tube 2 is that of the magnetic tube represented in Figs. 1 and 2. Hall sensor 5 is disposed centrally in the middle of magnetic tube 2. The entire measuring device 1 is disposed within a vacuum chamber 31 of an adjusting unit 30. By means of he measuring device 1, the position of a support 32 relative to its zero position can be measured and transmitted to the electronic system of the engine.

CLAIMS

What is claimed is:

1. Measuring device with a Hall sensor, particularly for displacement measurement, characterized in that the Hall sensor (5) is disposed centrally and in axially movable manner in a magnetic tube (2), each half of said magnetic tube (2) being cross-magnetized with opposite polarity.

2. Measuring device according to Claim 1, characterized in that the Hall sensor (5) is held in a support in axially displaceable manner, said support preventing the rotational movement of the Hall sensor (5) relative to the magnetic tube (2).

3. Method for fabricating a magnetic tube for the measuring device according to Claim 1 or 2, characterized in that a tube (2) made of magnetizable material is cross-magnetized in diametrically opposite manner so that one half (6) of the tube (2) is magnetized as the magnetic north pole (3) and the other half (7) of the tube (2) as the magnetic south pole (4), and that in the opposite direction the other half (7) of the tube (2) is provided with a magnetic north pole (3) and a magnetic south pole (4).

4. Method for fabricating a magnetic tube for the measuring device according to Claim 1 or 2, characterized in that a tube (2) made of magnetizable material is through-magnetized in the direction of its axis so that one half (16) of the tube (2) is magnetized as the magnetic north pole (3) and the other half (7) of the tube (2) is magnetized as the magnetic south pole (4) and that then the tube (2) is severed in its center (13) crosswise to its axis, and one part of the tube (6) or (7) is rotated 180° relative to the other part of the tube.

ABSTRACT OF THE DISCLOSURE

The invention relates to a measuring device comprising a hall sensor, particularly for measuring devices, which is characterized by the fact that the hall sensor is arranged in a centrally and axially movable manner in a magnet pipe. Each half of said magnet pipe is transverse-magnetized with opposite polarity.